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The Small Mammals of Isle of Wight County, Virginia, as Revealed by Pitfall Trapping,

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ABSTRACT

In a study conducted in mid-winter, pitfall traps were used to assess the small mammal communities on 14 grids set in open habitats in Isle of Wight County in eastern Virginia. In all, 136 shrews of three species and 103 rodents of five species were trapped. Least shrews (n=110) comprised 46 percent of small mammals and 80 percent of shrews. Eastern harvest mice (n=62) were the most common rodents. Reproduction was detected only in pine voles and southern bog lemmings. The majority of small mammals of the region were trapped during this month-long study.

INTRODUCTION

As part of a study to determine the western extent of populations of the then federally threatened Dismal Swamp southeastern shrew, *Sorex longirostris fisheri*, I conducted a survey of small mammals in Isle of Wight County, located just west of the City of Suffolk and lying approximately 40 km west of the Great Dismal Swamp National Wildlife Refuge in eastern Virginia. Using a standard protocol to study the Dismal Swamp southeastern shrew, an assistant and I established 14 study grids at different locations throughout the county. Trapping between 6 January and 6 February 1992, we collected 239 small mammals of eight species. This report relates the details of the types of small mammals, and their associations, in a coastal plain county in eastern Virginia.

MATERIALS AND METHODS

The southeastern shrew, the species of particular interest, is known to achieve greatest numbers in early successional habitats, such as oldfields, recently clearcut forests, and sites that are infrequently mowed (Rose et al. 1990). Powerline rights of way provide excellent habitat for such small mammals because they are mowed at 3-5 year intervals to prevent excessive growth of shrubs and trees, thereby continually setting back biological succession and promoting the persistence of perennial grasses and other herbaceous plants. Furthermore, because powerlines cross roadways, these habitats are easily reached, an additional benefit. Several high-voltage powerlines form a network across Isle of Wight County (Figure 1), many radiating from the Surry Nuclear power plant located on the south side of the James River. Thus, wherever county roads crossed the 30 m wide powerlines, I examined the vegetative stage of the habitat and usually was able to establish one or two study grids nearby.

The trapping grids were placed on sites with vegetation that is typical of early succession in the region. Grasses, mostly in the genera *Andropogon, Panicum*, and *Uniola*, dominated the vegetation of most grids, but sedges (*Carex* spp.) and even softrushes (*Juncus* spp.) were present on wetter places. Many grids had American cane (*Arundinaria gigantea*) and other woody elements, such as brambles (*Rubus* spp.), Japanese honeysuckle (*Lonicera japonica*), and tree seedlings, especially of sweet gum

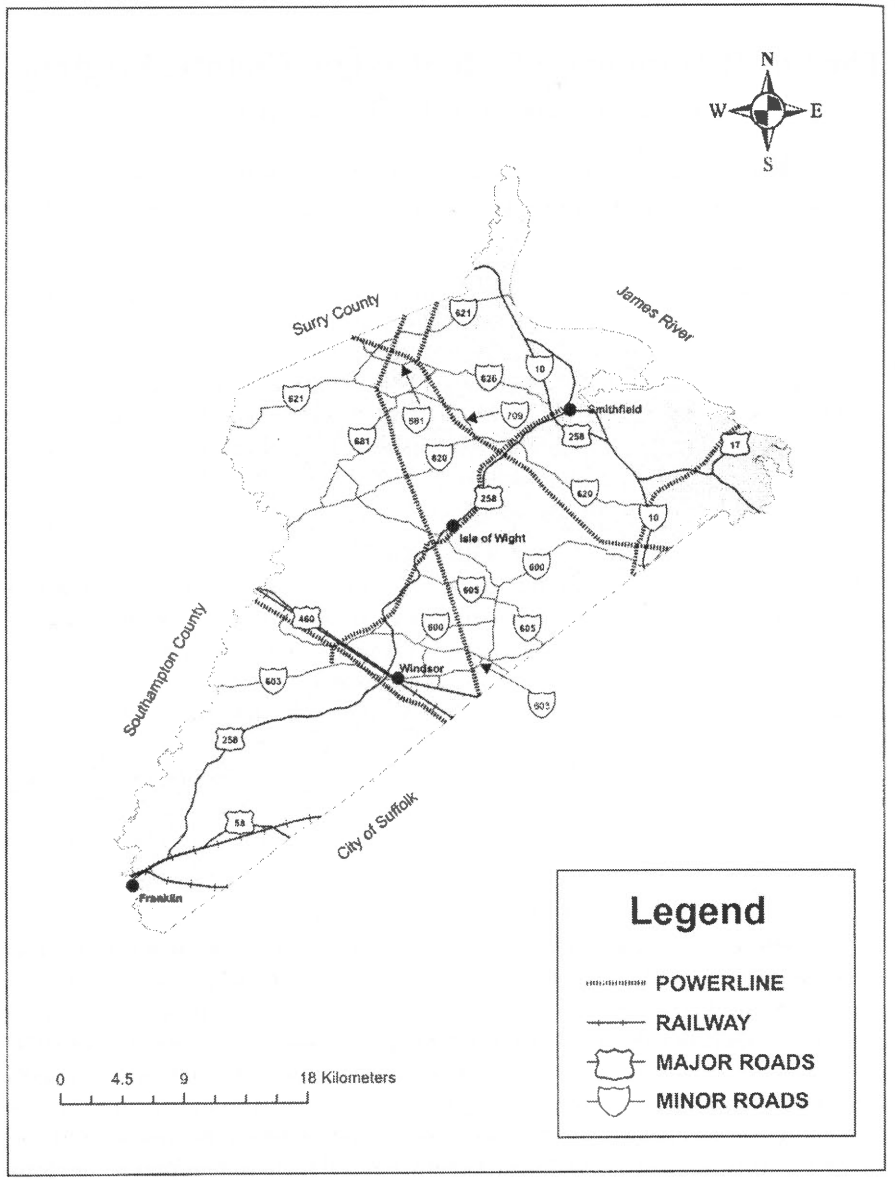

FIGURE 1. Map of Isle of Wight County, Virginia, showing the state roads and powerlines relevant to this study. The study grids were placed near where powerlines crossed the state roads, at locations listed in Table 1.

(*Liquidambar styraciflua*). The soils varied greatly among the 14 sites with grids, from sandy loams to silty clays, and occasional patches of black or peaty loams.

The standard trapping protocol for our shrew studies used a 5 X 5 grid with 12.5 m intervals, covering an area of 0.25 ha. Near each coordinate, we dug a 15 cm diameter hole, deep enough to accommodate a 15 X 23 cm #10 tin can. When partly filled with water or formalin solution, these serve as efficient pitfall traps, a common method to

secure some species of small mammals, especially southeastern shrews, that are resistant to being trapped by live or snap traps. These pitfall traps were unbaited, because early studies demonstrated that baiting did not increase their efficiency (Hudson and Solf 1959).

Once in place, we tended these traps twice a week to remove the bodies of small mammals that had fallen into the traps and drowned. (Drowning is considered to be a more humane method of kill-trapping than other methods, and we sought *Sorex* shrews whose body lengths we could measure). We trapped each grid for three weeks, and then removed all pitfalls from the ground. Earlier studies (Everton 1985) had indicated that little additional information is learned on the small mammals of a site if trapping continued beyond three weeks. Catch rates for pitfall traps tend to be very low, often on the order of 1-2 captures per 100 nights that a trap is in the ground.

Animals were frozen until they could be measured, weighed, and examined for reproductive status. At necropsy, each animal was weighed and then measured for total length and lengths of tail, ear, and hind foot. Each animal was examined for evidence of past or current reproduction (for females) or for current reproductive competency for males (the presence of convolutions in the cauda epididymides of the testes). All cataloged specimens were donated as skeletal material to the Mammal Division of the Smithsonian Institution in Washington, D. C. Because the field study was conducted in the dead of winter, I did not expect to see evidence of reproduction in most species.

RESULTS

In all, 239 small mammals of eight species were collected from the 14 grids in this study (Table 1). The number of specimens per grid ranged from 3-51 and the number of species per grid ranged from 2-6. Least shrews (*Cryptotis parva*) and eastern harvest mice (*Reithrodontomys humulis*) were taken on 13 of 14 grids, whereas the white-footed mouse (*Peromyscus leucopus*) and pine vole (*Microtus pinetorum*) were least common, from one and two grids, respectively. The short-tailed shrew (*Blarina brevicauda*), from seven grids, and southeastern shrew (*Sorex longirostris*), from six grids, also shared locations with least shrews on three grids. The microtine rodents, meadow voles (*Microtus pennsylvanicus*) and southern bog lemmings (*Synaptomys cooperi*), were present on seven and eight grids, respectively, and co-occurred on four grids.

The 239 small mammals collected in this study were taken in 3,750 trap-nights (one trap in place for one night equals one trap-night), for an overall capture rate of 3.25 small mammals per 100 trap-nights. The catch rates among grids ranged from 0.57 to 9.75/100 trap-nights (Table 1), indicating great variation in the densities of populations in the small mammal communities from location to location. There were no obvious vegetation or soil patterns that would account for this range of variation in small mammal abundance among the 14 grids.

Information on the number of specimens, their standard measurements, and other details is presented in Table 2 for the six species with sufficient specimens to permit calculations of standard statistics. Sex ratios of all species did not differ significantly from 1:1, nor was there statistically significant sexual size dimorphism. The mean number of species taken per grid was 4.07 and the mean number of individuals per grid was 17.07, but there was no significant correlation between the number of species and

TABLE 1. Results of pitfall trapping on 14 study grids in Isle of Wight County, Virginia. Grids were placed where state highways or other state roads intersected with high-voltage powerlines. Two grids were placed near state road 600, and three grids each were placed near state roads 621 and 626. "# sites" denotes to the number of sites yielding individuals of that species, "total N" refers to the total individuals of that species collected during the study, and "t-n" equals trap nights.

	Route 10	600/1	600/2	603	605	620	621/1	621/2	621/3	626/1	626/2	626/3	681	709	# sites	total N
Blarina brevicauda	1	3	2			2			3	2				1	7	14
Cryptotis parva	1	2	10		6	3	5	5	36	4	9	12	6	11	13	110
Sorex longirostris	1		2		3				2		3		1		6	12
Peromyscus leucopus				2											1	2
Reithrodontomys	5	4	2	1	16	3	4	3	7		5	5	3	4	13	62
Microtus pinetorum	1						2							1	2	2
M. pennsylvanicus	4								3	1	3	2	2		7	17
Synaptomys cooperi		4	2		4	1	1	1		1			6		8	20
Total individuals	13	13	18	3	29	9	12	9	51	8	20	19	19	16		239
Total species	6	4	5	2	4	4	4	3	5	4	4	3	6	3		
Catch rate/100 t-n	2.47	2.47	3.42	0.57	5.52	1.71	2.28	1.71	9.75	1.52	3.80	3.61	3.61	3.02		

number of individuals across the 14 grids ($r = 0.337$, $P = 0.24$). Thus, grids that yielded more individuals did not have more species than grids with few individuals.

Because this study was conducted in mid-winter, most of the animals collected were full adults and exhibited little evidence of reproduction. Exceptions were seen only in pine voles (female with five embryos and male was fertile) and southern bog lemmings, in which 15 g male and 18 g female, both late juveniles based on body size, were taken, plus two females were pregnant and all males of adult size were judged to be fertile. In all other species, the minimum sizes were those of adult animals (Table 2), and no evidence of reproduction was detected.

DISCUSSION

The three shrews and five rodents represent the majority of small mammals that are typical for the region. The shrews are all of the common ones; only the pygmy shrew, *Sorex hoyi*, was absent, and this tiny shrew has a patchy distribution, usually in shrubbier or more forested habitats than were examined in this month-long study of small mammals in the open habitats under powerlines. Among the rodents, only the introduced house mouse (*Mus musculus*) was absent among the mammals small enough to be contained by the 23 cm tall pitfall traps used in this study. House mice, introduced from Europe to the Americas during colonial times, are excellent colonizers of newly created and early successional habitats, but they tend to disappear once natural plant communities required to sustain native mammal populations have developed. Those conditions seemed to apply here. The hispid cotton rat, *Sigmodon hispidus*, likely was present on some grids but adults are too large to be caught in pitfall traps. The only other common small mammal in the region, the marsh rice rat (*Oryzomys palustris*), is associated with wet or regularly flooded sites, and thus was unlikely to be present on these mostly mesic sites.

The short-tailed shrew (*Blarina*) is perhaps the most common and widespread small mammal, and certainly is the most common shrew, in eastern North America. Tolerant of a wide range of conditions and thus found in habitats ranging from moderately dry oldfields to wet closed forests, this shrew is the largest North American shrew. The 14 collected in this study averaged 13 g (Table 2). Half the grids yielded short-tailed shrews, but only 1-3 individuals each, indicating that they were never as numerous as least shrews on these sites.

Short-tailed shrews have been studied extensively for their adaptations that enable them to sustain their high metabolic rates year round (no American shrew hibernates). For example, Merritt (1986) reports that this shrew possesses brown adipose tissue, a special fat that, when required, produces heat under stimulation from the adrenal gland. In effect, this is a supplementary or emergency source of heat production to that of shivering, the normal manner by which mammals produce heat on demand to get their sagging body temperatures back into the normal range. Their high metabolic rates also contribute to their remarkable abilities to produce young strictly through maternal energy sources during pregnancy and lactation. Pearson (1944) reports that an 11 g *Blarina* produced five weaned young that collectively weighed 55 g in just 50 days: 21 days for pregnancy and the rest for lactation. Two species of shrews in the genus *Sorex*, studied by Nagel (1994) in Germany, show a similar ability, producing young during pregnancy and lactation that were equivalent to 536 and 540 percent of the initial body weights of the mother shrews. Thus, besides an ability to mobilize sufficient

TABLE 2. The means, standard errors of means, minimal and maximal measurements for total length, tail length, weights, and the sample sizes for six species of small mammals taken in pitfall traps in Isle of Wight County, Virginia. Too few *Microtus pinetorum* and *Peromyscus leucopus* were caught to include in this table.

		MALES			FEMALES		
		Total length mm	Tail length mm	Weight (g)	Total length mm	Tail length mm	Weight (g)
Blarina brevicauda	Mean	115.0	25.57	14.26	114.43	26.86	12.34
	SE	2.49	0.75	0.56	1.64	1.26	0.32
	Min	109.0	22.0	11.71	110.0	23.0	11.50
	Max	127.0	28.0	16.40	123.0	31.0	13.61
	N	N=7			N=7		
Cryptotis parva	Mean	78.41	17.70	3.88	77.70	18.17	3.91
	SE	0.71	0.21	0.07	0.48	0.20	0.08
	Min	67.0	13.0	1.80	66.0	15.0	2.03
	Max	97.0	21.0	5.33	87.0	21.0	5.25
	N	N=56			N=64		
Sorex longirostris	Mean	89.86	34.57	3.08	88.75	33.50	3.15
	SE	0.70	0.65	0.27	0.22	0.25	0.11
	Min	88.0	33.0	1.74	88.0	33.0	2.80
	Max	93.0	38.0	3.95	89.0	34.0	3.56
	N	N=7			N=5		
Reithrodontomys humulis	Mean	122.56	58.66	8.58	118.57	56.47	7.94
	SE	1.44	0.92	0.19	1.72	0.87	0.29
	Min	109.0	49.0	6.21	105.0	48.0	4.19
	Max	140.0	69.0	12.03	140.0	68.0	11.41
	N	N=32			N=30		
Microtus pennsylvanicus	Mean	147.0	43.50	31.26	148.29	41.29	31.7
	SE	6.64	2.43	3.68	3.22	1.06	2.09
	Min	112.0	32.0	13.10	131.0	36.0	21.87
	Max	167.0	52.0	45.08	154.0	45.0	40.12
	N	N=10			N=7		
Synaptomys cooperi	Mean	118.54	20.69	27.96	128.86	23.0	32.17
	SE	2.44	0.86	2.09	4.72	2.90	3.79
	Min	102.0	15.0	14.63	117.0	18.0	24.05
	Max	129.0	26.0	41.63	151.0	40.0	47.36
	N	N=13			N=7		

energy to maintain a constant body temperature, female shrews are able to find additional energy from food to produce young equal to five times their own body weight in just 7-8 weeks. Because young shrews do not leave the nest to forage as juveniles but stay in nests until weaned at 95 percent of adult weight, their entire body weight gain after birth must come from the milk they acquire from their mothers.

The least shrew, the only brownish short-tailed shrew in Virginia, was the most numerous small mammal, with 56 males and 64 females (Table 2) collected from 13 of 14 grids (Table 1). Thus, they comprised 46 percent of total mammals. This shrew, at least in eastern Virginia, is mostly restricted to dry sites with mineral soils (Everton 1985). At less than 4 g in body weight, this is one of the dozen smallest mammals in the world. The number of least shrews per grid was highly variable, ranging from 1 or 2 to 9, 10, 11, to as many as 36. Distributed throughout Virginia in appropriate habitats, the highest densities have been reported by Adkins (1980) from tidal marshes on the Eastern Shore, specifically of Assateague Island. Least shrews are more social than other shrews, often forming groups. Jackson (1961) reports finding "about 25 shrews" in a leaf nest in Virginia and McCarley (1959) describes the well-insulated nest in which he found "at least 31 shrews" in early January in eastern Texas.

The southeastern shrew, the primary subject for which this study was undertaken, was found on 6 of 14 grids, always in low numbers (1-3 per grid). All were similar in size, weighing < 4 g and measuring nearly 90 mm in body length (Table 2). The most common long-tailed shrew in eastern Virginia, it is slightly longer and heavier than the pygmy shrew. Longer shrews of the Dismal Swamp subspecies, *Sorex longirostris fisheri*, ranging in body length to near or slightly above 100 mm, are found mainly in wet sites with peaty soils, whereas the upland subspecies, *S. l. longirostris*, is somewhat smaller, with lengths in the low to mid-80s mm range (Everton 1985). Three of the six grids yielding southeastern shrews also had the other two shrew species present as well. Before the regular use of pitfall traps, the southeastern shrew was considered to be one of the rarest American shrews throughout its distribution in the southeastern states. Many of the first or second state records were of specimens found dead on trails, dug from nests in rotting logs, or found floating in water-filled stumps or receptacles at the bottom of downspouts. However, with the systematic use of pitfall traps, initially by French (1980), southeastern shrews often are the most numerous small mammal species of a site. This result also was found to be true in eastern Virginia (Everton 1985), especially on wet or damp sites.

The white-footed mouse, *Peromyscus leucopus*, is a forest-dwelling arboreal rodent that occasionally is present in early successional sites. The two specimens collected on the grid near state road 603 were sub-adults in gray pelage, and likely were animals dispersing from one nearby forest to another. The white-footed mouse is considered the most common rodent in forests in eastern North America.

The eastern harvest mouse, *Reithrodontomys humulis*, was by far the most numerous rodent, with 62 being taken on 13 of the 14 grids (Table 1). These 62 harvest mice represented 60 percent of all rodents and 25 percent of all specimens taken in the study. The number per grid was usually small, five or less but two grids yielded 7 and 16 specimens. The smallest rodent in eastern North America (< 10 g), harvest mice eat insects and seeds and build aerial nests in tufts of grasses. Only pregnant females exceed 10 g. This nocturnal species often is numerous on sites with tall herbaceous vegetation such as was present on most of the grids. Cawthorn and Rose (1989), who studied the

dynamics of a population of eastern harvest mice in similar oldfield habitat in Portsmouth, Virginia, found densities to be some of the highest of any harvest mouse in North America, so their ubiquity and numbers are not surprising in the present study. Harvest mice are often found in association with hispid cotton rats, a species almost always the largest rodent in the same oldfields (Cameron 1977; Cameron et al. 1979; Joule and Cameron 1975; Rose pers. obs. in southern Chesapeake in an on-going study). The reasons for this association remain to be revealed.

The other three small mammals are short-eared, short-tailed animals in the subfamily Microtinae of the Order Rodentia. Most microtine rodents have the common names of voles and lemmings, but the muskrat (*Ondatra zibethicus*) is the largest member of this group of strict herbivores. Microtines are intermittently active day and night, have high metabolic rates, and are exceedingly efficient at turning grass into flesh. Sometimes microtines breed year-round (even in the arctic!) and so members of this group had the greatest potential to exhibit reproduction during this study, conducted in mid-winter.

The meadow vole flourishes in grassy fields, wet or drier, and is considered the most common and widespread herbivorous rodent in eastern North America. I caught 17 on seven grids, usually in low numbers (1-4 per grid). Many grids had too little covering vegetation to support populations of meadow voles: some studies indicate that 90 percent covering vegetation is required (review by Getz 1985). Before the arrival of hispid cotton rats into Virginia in 1940 or slightly before (Patton 1941), the meadow vole was the largest rodent in grassland or early successional habitats and as such was the staple in the diets of snakes and carnivorous mammals and birds. Meadow voles build runways through grassy vegetation, which they maintain by clipping the vegetation that grows in their footpaths. They frequently build feeding runways off the main trails, and there they sit on their haunches and, using their sharp incisors, cut the grasses into 3-5 cm sections until they get to the most palatable and nutritious bits, which they consume. Thus, their presence can often be told by the small piles of cut vegetation in runways. In the winter, they are able to sustain themselves by eating, if necessary, dead and dried grasses and by conserving energy during their hours of inactivity in well-insulated subterranean nests.

The pine vole, also sometimes and more appropriately called the woodland vole, is a smaller and shorter-tailed version that lives in early successional habitats but more typically at low densities in woodlands. Thus, its habitat requirements or tolerances are broader than those of the meadow vole. Unlike the brownish black and scruffy-haired meadow vole, the pine vole has a short velvety pelage of a uniform chestnut-brown color. Its tail is only as long as its hind foot, compared to the tail of the meadow vole, which is twice as long as the hind foot. Pine voles, which build shallow burrow systems 3-5 cm below the surface, sometimes are economic pests, especially in orchards, because they eat the bark off the root systems of trees and shrubs, sometimes girdling and killing the plant. The pine vole is present in low densities in mature forests throughout its range in eastern North America, but often reaches higher densities in early successional habitats, such as recently clearcut forests. In the present study, only one male and one female were collected, on separate grids. Called the pine vole because the specimens from which the species was described and named came from pine forests in South Carolina, we now know that pine voles are rare in pine forests and much more abundant in deciduous forests, hence the alternative common name of woodland vole.

Finally, perhaps the most interesting small mammal to be collected was the southern bog lemming. Similar in size and proportions to the pine vole but with a grizzled grayish pelage and a squarish nose with its exceedingly long and 'busy' nasal whiskers, this species generally is thought to require wetter habitats than the other microtine rodents (as the common name suggests). In Virginia, the southern bog lemming is found in some cool wet habitats in the montane west, such as in Montgomery and Giles counties near Blacksburg, but an isolated subspecies, *Synaptomys cooperi helaletes*, is known only from the Dismal Swamp region. Until I caught several in pitfall traps in the Great Dismal Swamp National Wildlife Refuge in early 1980 (Rose 1981), some investigators (such as Handley 1979) speculated that this subspecies might be extinct. The southern bog lemming is another species rarely caught in live or snap traps (Rose et al. 1990; Stankavich 1984), but pitfall trapping studies have revealed it to be widespread and locally common in some locations. In this study, I collected 20 southern bog lemmings on 8 of the 14 grids, making it more numerous and widespread than either species of *Microtus*. Most of the grids yielded one or two specimens but two grids yielded four and one six specimens. The results of this study show that the Dismal Swamp southern bog lemming is flourishing beyond the bounds and habitats of the Dismal Swamp.

Among the small mammals collected in this mid-winter study, evidence of reproduction was seen only in pine voles and southern bog lemmings. The lone female pine vole had five embryos and the male was judged to be fertile, based on the presence of sperm in the cauda epididymides. Two southern bog lemmings were pregnant, and all adult-sized males were judged to be fertile. That winter breeding occurred is also supported by the two juvenile southern bog lemmings taken in the pitfall traps. Surprisingly, no female meadow vole was pregnant and all males were judged to be infertile. No embryos were found in any species of shrew or in harvest mice, so only the southern bog lemming and pine vole were reproducing over the winter.

In conclusion, the small mammals of Isle of Wight County presented few surprises, except perhaps the widespread presence and abundance of least shrews and the presence of southern bog lemmings so great a distance from the Dismal Swamp. It seems likely to me that southern bog lemmings will be found even farther westward from the Dismal Swamp, provided that searches using pitfall traps are made in appropriate habitats.

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